ASSESSMENT OF SOIL FERTILITY MANAGEMENT PRACTICES OF WHEAT IN WESTERN TERAI OF NEPAL

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ABSTRACT

A study was conducted to assess the soil fertility management practices and their constraints in sixty households of western terai of Nepal namely Barrohiya (Kapilvastu), Rehara (Rupandehi) and Sanda (Nawalparasi) in 2013 by using simple random sampling techniques. A semi-structured interview schedule was used for the collection of the data. Eighty percent of the interviewed farmers had medium land holding size (7.5 to 82 Katha). Most of the land was irrigated (>81 percent) and medium upland type (53.48 percent). Farmers in those areas weren't practicing green manuring but were habituated to incorporate legumes (pea, lentil, black gram, beans, etc.). Chemical fertilizer was the main source of nutrient (56 percent) for wheat crop. Urea and DAP were commonly used by farmers whereas MoP was rarely used. Farmers of Kapilvastu applied the highest amount of Urea (165 Kg/ha) where as the amount of DAP (116.9 kg/ha) and MoP (27.8 Kg/ha) used was more in Nawalparasi than other two in wheat crop. On an average the farmers applied 13.3 kg/ha MoP which is very low as compared to recommended dose (41.7 kg/ha). There were number of constraints and obstacles perceived by the farmers. Arrangement must be made on those areas for time availability of fertilizers and farmers must be made aware about adequate use of quality chemical fertilizers and proper soil nutrient management.

Keywords: Soil fertility, farmers, chemical fertilizer, Urea and DAP, wheat

INTRODUCTION

It is a well-known fact that soil fertility management plays a vital role in increasing crop productivity and production to address the problem of food security and income generation of farming households. But the farmers have not adequately applied these measures to enhance overall system productivity because they are deprived of the access to resources, knowledge and skills on sustainable soil fertility management (FORWARD, 2006). The problems of soil quality deterioration and fertility decline are prevalent throughout the world (Harden 2001 and Lal 2001). One reason is the decreasing use of organic matter like crop residue and farmyard manure (FYM)/compost due to the increasing trend of intensive farming. Also, farmers are unable to use the recommended dose of chemical fertilizers due to unavailability, high cost, and a reduction of subsidies to support farmers in the agricultural sector. Additionally, inadequate practices of soil conservation and nutrient management contribute to the nutrient depletion soil fertility. Hence, there is a serious problem of possible decline in agricultural production due to nutrient depletion particularly in rice-wheat cropping system. Due to heavy depletion of plant nutrients, soils and the system show signs of fatigue, and there is a general decline in yield of rice and wheat and a decrease in partial factor productivity of the fertilizer applied. All of these together contribute to low productivity of crops. By introducing legume crops in cropping systems, soil fertility and productivity could be increased for crop production because legumes are able to fix nitrogen in their root and supply residual nitrogen to following cereal crop (Kumbhar et al., 2007).

Soil fertility is largely maintained by the application of compost and manure but in recent years a decline in soil fertility has been reported (Shrestha et al., 2000). There has been considerable research in Nepal on soil fertility enhancement and soil and water conservation techniques over the years (Keatinge et al., 1999 and Acharya et al., 2000). Even though the decline in soil fertility is a major concern for most farmers (Turton et al., 1995), their adoption of improved techniques has been limited (Shrestha et al., 2000). Although much of this is due to poor dissemination pathways resulting from inadequacies in the agricultural extension system, an important factor may be the different ways that farmers, extension workers and researchers all perceive and assess soil fertility, leading to differences in the problems perceived and solutions required. Until recently, farmers' knowledge of soil fertility has been largely ignored by soil researchers but with increasing use of participatory research approaches, it is becoming clear that farmers have a well-developed ability to perceive differences in the level of fertility between and within fields on their farms. There is a strong need to compare the indicators used by farmers with those used by researchers. In this paper, we build on the findings of these previous descriptions by studying farmers' perceptions and assessment of soil fertility. The following were the major objectives of the study:

- To assess the soil fertility management practices in farmers' field
- To identify the farmers fields soil fertility status.
- To find out nutrient management constraints and their remedies

MATERIALS AND METHOD

Site description

The study was conducted from October to November in 2013 in western terai of Nepal. The three sites Pakadi VDC ward no.-3, Barrohiya of Kapilvastu district; Ramgram municipality ward no.-1, Sanda of Nawalparasi district and Tukuligadh VDC ward no.-1, Rehara of Rupandehi district whose altitude range from 80-120 masl were selected purposively and 20 households from each of two VDCs and one municipality were selected by using simple random sampling techniques. A semi-structured interview schedule was used for the collection of the data.

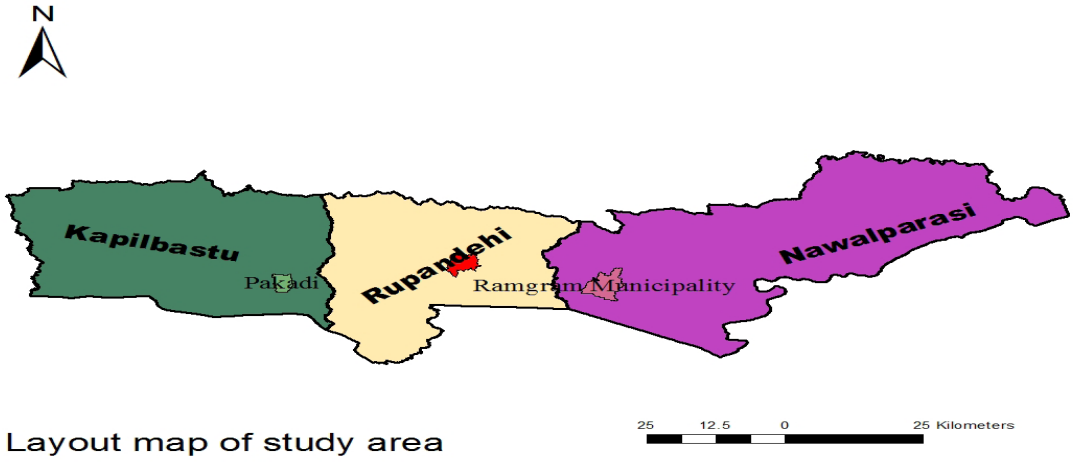

Figure 1: Location map of study area

Household interviews

Sixty households of western terai of Nepal 20 households from each of two VDCs and one municipality were selected by using simple random sampling techniques. Information on farmers' perceptions of soil fertility and soil fertility management practices was gathered through individual semi-structured interviews which took place in the interviewee's house. Interview topic covered soil fertility management practices, local methods used to assess the fertility status of a field and perceived trends in soil fertility and availability of chemical fertilizers. Special care was taken to ensure that the most experienced member of the household was interviewed. The few fields that were rented out to other farmers, or fields that were being rented by the interviewee, were excluded from the discussions to minimize errors due to a possible lack of knowledge regarding the management of these fields. Information on the soil characteristics and management practices of wheat crop were obtained from discussions with the farmer during the interview.

Soil sampling and analysis

Soil samples were also collected from each of the selected farmers fields described above. Each soil sample was randomly collected from the 0 to 20 cm deep plough layer using an auger. For this, the air-dried samples were crushed and passed though a 2mm sieve. Soil pH was determined by a pH meter after extraction from a soil: water ratio of 1:2. Organic matter was determined using the Walkley and Black dichromate method (Nelson and Sommers, 1982) and total N using Kjeldhal's method (Bremner and Mulvaney, 1982) For available P determination, modified Olsen's (Olson and Sommers, 1982); exchangeable K (Knudsen et al., 1982) was estimated from one normal ammonium acetate extraction adjusted to pH 7 using flame photometer.

Methods and techniques of data analysis

After collection of necessary information it was coded and entered to computer for analysis. Data was fed to Microsoft excel and analysis was done by using statistical packages for social sciences (SPSS). Qualitative information obtained during the field survey like cropping pattern, variety of crops, situation of insect/pests, soil condition, etc. were qualitatively analyzed and expressed. Quantitative data were analyzed by using the both descriptive and analytical statistics. Socioeconomic and farm characteristics of the respondents like family size, age, occupational status, land holding size, irrigation facilities, fertilizers use, etc. were described using simple descriptive statistics like frequency count, percentage, mean, standard deviation etc.

RESULTS AND DISCUSSION

Socio-demographic Characteristics of study area

Socioeconomic factors are most important and always remain responsible for not only cropping patterns but for production technology and efficient trading system in a healthy and competitive environment. The socio economic characteristic of respondents include age distribution of the respondent, population and gender distribution, family size, occupation, land utilization pattern and cropping pattern. The key characteristics of the sample households, including the gender, age group, family size and cultivated land area of the interviewees and are summarized in Table 1.

Agriculture is the primary source of income for almost all the respondents in the study area. More than 93 percent family have less than 3 ha of land. The average age of the household head was 46 years and more than 68% were middle aged farmers (31-61 years). It can be depicted from table 1 that the family size was greater in all three sites, particularly, 80 percent in Barrohiya and 95 percent in Sanda and 70 percent in Rehara had family members greater than five. Average family size in the study area (8.5) was higher than the national average of 4.7 (CBS, 2011).

Table 1: Respondents Socio-demographic Characteristics

Characteristics	Kapilvastu (Barrohiya)	Nawalparasi (Sanda)	Rupandehi (Rehara)	Total
Sex				
Male	20(100.0)	20(100.0)	18(90.0)	58(96.7)
Female	0(0.0)	0(0.0)	2(10.0)	2((3.3)
Age group				
Less than 31 (Young farmers)	4(20.0)	3(15.0)	4(20.0)	11(18.3)
31-61 (Middle aged farmers)	13(65.0)	14(70.0)	14(70.0)	41(68.4)
More than 61 (Old farmers)	3(15.0)	3(15.0)	2(10.0)	8(13.3)
Family Size				
Less than 5 (small family)	4(20.0)	1(5.0)	6(30.0)	11(18.3)
5-12 Medium sized family)	10(50.0)	17(85.0)	12(60.0)	39(65.0)
More than 12 (large family)	6(30.0)	2(10.0)	2(10.0)	10(16.7)
Cultivated land area (Kattha)				
Less than 7.5 (small farmers)	2(10.0)	1(5.0)	5(25.0)	8(13.33)
7.5-82 (medium farmers)	16(80.0)	17(85.0)	15(75.0)	48(80.0)
More than 82 (large farmers)	2(10.0)	2(10.0)	0(0.0)	4(6.67)

*Figures in parentheses indicate percentage (Source: Field survey, 2013)

The average cultivable land holding of the respondents was found 44.75 kattha (1.49 hectare) which is slightly greater than the national average 0.8 hectare. Eighty percent of the respondents had medium farm size (7.5-82 kattha). Most of the land in the study sites was irrigated (>81 percent) and medium upland type (53.48 percent) which is illustrated in table 2. Irrigation canal, ground water and pumping from rivers and pound were main source of irrigation in the study area. On an average seventy percent of the respondent, irrigate their wheat field once at 20-25 DAS which corresponds to CRI stage of the crop where as remaining 30 percent of the farmers irrigate their field twice during the wheat growing period (20-25 DAS and 40-45 DAS).

Table 2: Irrigation condition and land type of the study area

Characteristics	Kapilvastu (Barrohiya)	Nawalparasi (Sanda)	Rupandehi (Rehara)	Total
Irrigation condition				
Irrigated land	722(84.5)	557(69.1)	548(94.6)	1927(81.7)
Non-irrigated land	151(15.5)	249(30.9)	31(5.4)	431(18.3)
Land type				
Very Lowland	574(58.99)	217(26.92)	306(52.85)	1097(46.52)
Medium upland	399(41.01)	589(73.08)	273(47.15)	1261(53.48)
Total	973(100)	806(100)	579(100)	2358(100)

*Figures in parentheses indicate percentage (Source: Field survey, 2013)

Soil fertility status of farmers' field in the study areas

The soil of study areas was found to be slightly alkaline to alkaline with very low to low organic matter, low total nitrogen, medium available phosphorus and on medium available potassium. In Barrohiya (Kapilvastu), pH was slightly alkaline with an average of 7.6 (ranges from 6.7 to 8.7),

organic matter range from 0.28 to 1.73 (very low) with an average of 0.98. Similarly, nitrogen content of the soil was very low with an average of 0.07 whereas available phosphorus and potasium was medium with average of 74.1 kg/ha and 195.9 kg/ha, respectively. Similarly, in Sanda (Nawalparasi), pH was slightly alkaline with an average of 7.6, organic matter range from 0.35 to 3.12 (low) with an average of 1.37.

Table 3: Soil fertility status of farmers' field in the study areas

Treats	pH	Organic Matter (%)	Nitrogen (%)	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1}
Kapilvastu (Barrohiya)					
Lowest	6.7	0.28	0.05	36.7	108.3
Highest	8.7	1.73	0.09	101.1	320.1
Average	7.6	0.98	0.07	74.1	195.9
Rating	Slightly alkaline	Very low	Low	Medium	Medium
Nawalparasi (Sanda)					
Lowest	7.3	0.35	0.05	24.7	103.1
Highest	8.6	3.12	0.13	103.0	294.6
Average	7.6	1.37	0.08	64.9	124.9
Rating	Slightly alkaline	Low	Low	Medium	Medium
Rupandehi (Rehara)					
Lowest	7.2	0.55	0.06	20	90.7
Highest	8.6	3.12	0.13	81	230.6
Average	8.0	1.66	0.09	44.3	103.4
Rating	Alkanline	Low	Low	Medium	Low

Similarly, nitrogen content of the soil was very low with an average of 0.08 whereas available phosphorus and potasium was medium with average of 64.9 kg/ha and 124.9 kg/ha, respectively. The soil of Rehara (Rupandehi) was found to be alkaline with low organic matter (1.66), low total nitrogen (0.09), medium available phosphorus (44.3 kg/ha) and low available potassium (103.4 kg/ha).

Crop and soil management practices

Agriculture was the main occupation of almost population of the surveyed households. Rice-wheat was the major cropping pattern in the study areas followed by rice-pea, rice-mustard, rice-lentil, rice-potato and others. Green manuring was not practiced much but farmers were found to be incorporating legumes (pea, lentil, black gram, beans, etc.). Legume integration practice plays important role in maintaining continuous soil fertility.

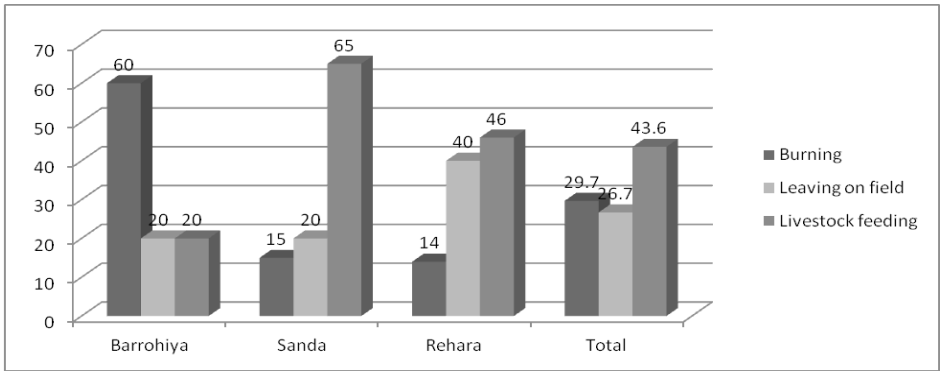

Figure 2: Crop residue management in the study area

Most farmers of the study area in Kapilvastu burn the crop residues whereas majority of farmers in Nawalparasi and Rupandehi use them for livestock feeding. However, crop residue burning problem was serious in all the three districts. Sixty percent of the respondents of the study area in Kapilvastu district burnt their crop residue where as sixty five percent of farmers from Nawalparasi and forty six percent of farmers from Rupandehi district used to save the crop residue for feeding the livestock. Only six respondents among sixty tested the soil but no report has been obtained.

Table 4: Crop management practices in wheat in study areas

Practices	Kapilvastu (Barrohiya) (n=20)	Nawalparasi (Sanda) (n=20)	Rupandehi (Rehara) (n=20)	Total (n=60)
Green manuring				
No manuring	20(100.0)	20(100.0)	18(90.0)	58(96.7)
Dhaicha	0(0.0)	0(0.0)	2(10.0)	2(3.3)
No of irrigation				
One	12(60.0)	18(90.0)	12(60.0)	42(70.0)
Two	8(40.0)	2(10.0)	8(40.0)	18(30.0)
No of plowing				
Once	4(20.0)	4(20.0)	0(0.0)	8(13.3)
Twice	4(20.0)	2(10.0)	4(20.0)	10(16.7)
Thrice	8(40.0)	0(0.0)	4(20.0)	12(20.0)
Four times	4(20.0)	14(70.0)	12(60.0)	30(50.0)
Weed management				
No management	0(0.0)	0(0.0)	2(10.0)	2(3.3)
Manual	8(40.0)	16(80.0)	12(60.0)	36(60.0)
Chemical	2(10.0)	0(0.0)	4(20.0)	6(10.0)
Manual and chemical	10(50.0)	4(20.0)	2(10.0)	16(26.7)

*Figures in parentheses indicate percentage (Source: Field survey, 2013)

All the farmers in the study area practiced convention type of tillage using tractor (86.3%) and only 13.7 % use draft animal drawn as tillage source. Majority of the farmers (50%) prepare the fields fine by ploughing the fields upto four times. The number of ploughings in Kapilvastu district was less as compared to the other two districts. The farmers in the study area manage the weeds manually (60%). Ten percent farmers used chemicals only and 26.7 percent of the selected farmers used both manual and chemical methods to control the weeds in their wheat fields. Butachlor and 2,4-D were the main two weedicide used by the farmers. All the farmers in the study areas broadcast the seed @ 5.4 kg/kattha without seed treatment and no biofertilizer was used. Bhrikuti, Gautam, NL 297, Vijay, NL 1073, Aditya, NL 1053 and Indian variety PBW 343 were major wheat varieties used by the farmers in the study areas.

Farm yard manure application in the field

The time of organic manure application play important role in nutrient availability. The commonly used organic source of nutrient in Nepal is FYM which was also found to be practiced by the farmers in the study area. On an average fifty seven percent of the farmers apply the FYM one month before sowing, 26.9.% applied 15 days before sowing where as only 16.5 percent used FYM at the time of sowing of wheat. Majority of the farmers in the study area in Rupandehi (50%)

incorporate FYM two weeks before sowing which is the appropriate time of application of FYM in the field.

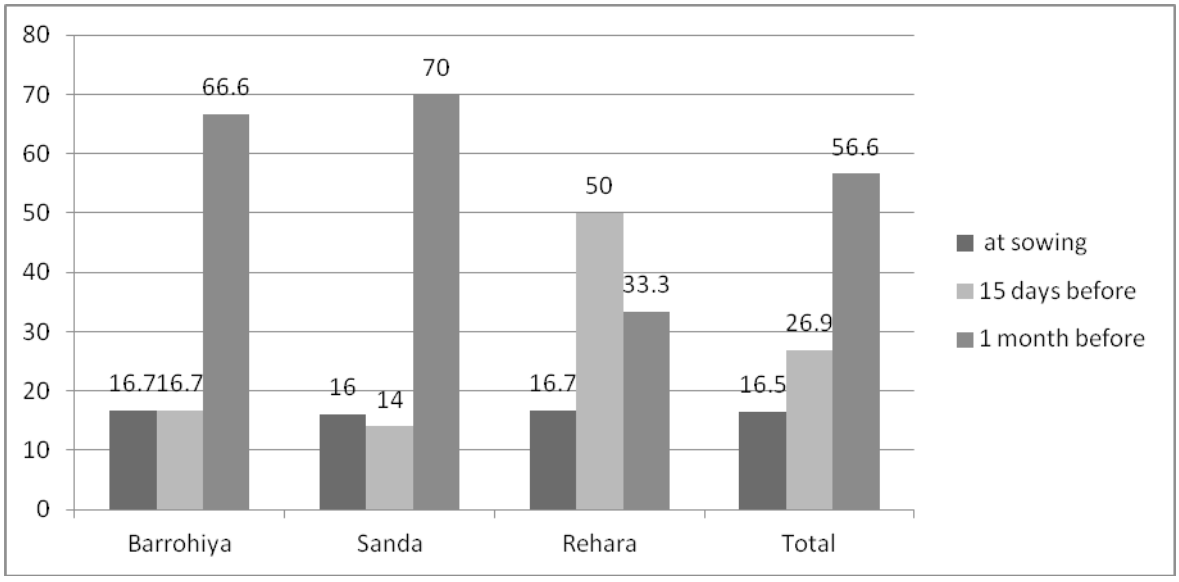

Figure 3: Percentage of farmers applying FYM in the field of the study area (n=60) (Field survey, 2013)

Organic manure and chemical fertilizers used in wheat crop

Inorganic chemical fertilizer was the main source of nutrients in all the three study areas. Fifty seven percent of the respondents used only the chemical fertilizer whereas three percent of them used organic manure only and the remaining forty percent used both sources of fertilizers as the source of nutrients in the wheat crop.

Table 5: Organic manure and chemical fertilizers used in wheat crop

Location	Kapilvastu (Barrohiya) (n=20)	Nawalparasi (Sanda) (n=20)	Rupandehi (Rehara) (n=20)	Total (n=60)
Source of nutrient				
Organic	0(0.0)	0(0.0)	2(10.0)	2(3.3)
Inorganic	10(50.0)	14(70.0)	10(50.0)	34 (56.7))
Mixed	10(50.0)	6(30.0)	8(40.0)	24 (40.0))
Availability of chemical fertilizer				
Easily available	0(0.0)	11(55.0)	4(20.0)	15(25.0)
Moderately available	2(10.0)	2(10.0)	6(30.0)	10 (16.7)
Hardly available	18(90.0)	7(35.0)	10(50.0)	35 (58.3)
Basis of fertilizer application				
Technician advice	2(10.0)	0(0.0)	0(0.0)	2 (3.3)
Self estimation from past experience	16(80.0)	16(80.0)	20(100.0)	52 (86.7)
Neighbour advice	2(10.0)	4(20.0)	0(0.0)	6(10.0)
Urea split application				
No	0(0.0)	2(10.0)	0(0.0)	2(3.3)
Twice	19(95.0)	17(85.0)	18(90.0)	54 ((90)
Thrice	1(5.0)	1(5.0)	2(10.0)	4(6.7)

*Figures in parentheses indicate percentage (Source: Field survey, 2013)

When respondent were questioned about the availability of chemical fertilizer, majority of the respondent (58.3 percent) responded that fertilizer was hardly available, 16.7 percent answered that fertilizer was moderately available and the remaining 25 percent thought that the fertilizer was easily available at sowing time of wheat. In all the three locations, the basis of fertilizer application was found to be self estimation of farmers themselves from past experience (86.7%). Only 3.3 percent of the respondent used the recommended fertilizer dose advised by the technician. Nearly all the farmers of the three locations used urea in split application. Ninety percent of farmers used the urea in split dose one as basal at the time of sowing and the other at 25-30 DAS after first irrigations.

Table 6: Amount of seed rate, chemical fertilizers used by farmers and productivity of wheat in the study area (n=60) (Field survey, 2013)

Amount (kg/ ha)	Recommended (straight fertilizer)	Kapilvastu (Barrohiya)		Nawalparasi (Sanda)		Rupandehi (Rehara)		Avg	
		applied	deficit/ surplus	applied	deficit/ surplus	applied	deficit/ surplus	applied	deficit/ surplus
Seed	120	104.7	-15.3	146.3	+26.3	145.2	+25.2	162.5	+42.5
FYM	6 ton/ha	3.24	-2.76	4.56	-1.44	3.02	-2.98	3.6	-2.4
Urea	175.0	165.0	-10.0	143.1	-31.8	107.3	-67.7	138.8	-36.2
DAP	108.7	102.4	-6.3	116.9	+8.2	85.2	-23.5	101.5	-7.2
MOP	41.7	7.5	-34.2	27.8	-14.0	4.5	-37.2	13.3	-28.5
Wheat productivity	3027(WR)	3192		2930		2514		2879	

Note: WR=Western Region

Manure is also essential for sustainable yields and ways must be found to increase the amount of manure applied to crops because the amount of manure applied by the farmers is very low as compared to the recommended dose. Commercial chemical fertilizers Urea and DAP were commonly used by farmers of the all three districts whereas MoP was rarely used. Farmers of Kapilvastu applied the highest amount of urea (165 Kg/ha) where as the amount of DAP (116.9 kg/ha) and MoP (27.8 Kg/ha) used was more in Nawalparasi than the other two. DAP applied by the farmers of Nawalparasi district was 8.2 kg/ha more than the National recommendation (108.7 Kg/ha) dose where as the farmers of Kapilvastu and Rupandehi districts used 102.4 kg/ha and 85.2 kg/ha DAP respectively which is below the national recommendation. The dose of urea used by the farmers of Nawalparasi and Rupandehi was 31.8 and 67.7 kg/ha lower than the required dose (175 kg/ha). On an average the farmers of the study areas in three districts applied 13.3 kg/ha MoP which is very low as compared to recommended dose (41.7 kg/ha). The farmers of Barrohiya (Kapilvastu) used low seed rate (104.7 kg/ha) of wheat than the recommended rate (120 kg/ha) where as farmers of Sanda (Nawalparasi) and Rehara (Rupandehi) used more seed rate than required. The average productivity of wheat in the study area was found to be 2.9 ton/ha which is greater than the national average (2.4 ton/ha) and lesser than the average of the western region (3.03 ton/ha).

Nutrient management constraint and obstacles

There were number of constraints and obstacles perceived by the farmers of the survey sites for the management of nutrient which includes high cost of fertilizer, lack of sufficient supply of quality chemical fertilizer, lack of access to information and training on nutrient management and no government support and policies regarding nutrient management.

Suggestion for management of problem

The farmers should be made aware of the balanced fertilizer application so as to improve the productivity of the crop. Government should make such a policy and strategy so that the quality fertilizer will be available in time for the proper nutrient management of the crop. Training related to proper nutrient management should be organized regularly by the concerned authorities (ADO and agriculture service centres).

CONCLUSION

The results presented in this paper indicate that there is low soil fertility status in farmers' field especially very organic matter and nitrogen content. In the Nepal context, the expertise of both farmers and researchers is important if more sustainable techniques of soil management are to be devised an implemented. Researchers can provide the breadth of understanding of soil biophysical processes gained from experiences world-wide, whereas farmers can provide the context-specific knowledge required to adapt this understanding to local biophysical and socio-economic conditions. Local agricultural extension staff can play an important role in enhancing this essential link between the two worlds.

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